COMMUNITY HEALTH MAPPING
IN A WORLD AWASH WITH GEOGRAPHIC DATA & TOOLS

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Community Health Maps Symposium
7-8 June, 2016
Today’s Itinerary

- The Value Proposition
- The Spatial Sciences
- Connecting Health & Place
- Role of Geographic Data
- Role of Geospatial Tools
  - Community Mapping Applications
- Some Enduring Challenges
- Conclusions
The Value Proposition

- A single database supports multiple maps
- The visual trumps both text & numbers
- Future is 4D (latitude, longitude, height & time)
Spatial Sciences Institute

- Established 1st July, 2010
- Rapid growth
- People
  - 15 core faculty
  - 21 faculty affiliates
  - 7 staff
- Facilities
  - Faculty & staff offices
  - Dedicated classrooms & laboratories
  - Large computing infrastructure
- Substantial research enterprise
- Full suite of academic programs
SSI’s unique and competitive academic position: Interdisciplinary courses and degrees at every level

- Large General Education courses
- Minor in Spatial Studies
- Minor in Human Security & Geospatial Intelligence
- **B.S. in GeoDesign**
- GC in GIScience & Technology (online)
- GC in Geospatial Intelligence (online)
- GC in Geospatial Leadership (online)
- **M.S. in GIScience & Technology**
- **M.S. in Spatial Informatics**
- GeoHealth track in MPH degree (online)
- **Ph.D. in Population, Health & Place**
MPH | GeoHealth

- Keck School of Medicine of USC
- Online degree
- Six core courses
- Four concentrations
  - Biostatistics & Epidemiology
  - Health Education & Promotion
  - Global Health Leadership
  - GeoHealth
- GeoHealth Concentration
  - Concepts for Spatial Thinking
  - Spatial Analysis
  - Spatial Modeling
  - Remote Sensing for GIS
  - Cartography & Visualization
- Practicum

Population, Health & Place

- Geography of Life and Death
- PHP Research Practicum

- Population
  - Quantitative Methods and Statistics II
  - Social Demography
  - Demographic Methods

- Health
  - Principles of Biostatistics
  - Principles of Epidemiology
  - Environmental Health: An Epidemiological Approach

- Place
  - Principles of Spatial Data Analysis
  - Spatial Modeling with GIS
  - Spatial Computing

- Electives
- Dissertation
Health & Place

- **Disease surveillance**
  - Exploratory disease mapping to generate hypotheses for subsequent etiological studies
  - Disease modeling to inform policy related to public health initiatives

- **Risk analysis**
  - Impact of environmental exposures on health outcomes
  - Point- or line-source studies

- **Health access & planning**
  - Network analysis & market segmentation studies

- **Community health profiling**
  - Compilation of community infrastructure & other data which influence health (SES, health-related policies & behaviors)

(Source: Nykiforuk & Flaman, 2011)
Disease Surveillance

Heart Disease Death Rates, 2011-2013
Adults, Ages 35+, by County

Rates are spatially smoothed to enhance the stability of rates in counties with small populations.

Data Source:
National Vital Statistics System
National Center for Health Statistics

CDC

USC Dornsife
Dana and David Dornsife
College of Letters, Arts and Sciences
Risk Analysis

Washington Radon Exposure Risk Map
Source: CDC
Health Access & Planning

Source: Abt Associates
Community Health Profiling

Percent of Population Under Age 65 without Health Insurance, 2013

Data Source: 2013 Small Area Health Insurance Estimates from the U.S. Census Bureau. Does not include those with Indian Health Service coverage only.
Atmosphere

PM 2.5
Precipitation
Temperature
UV Radiation
Elevation

NED
National Elevation Dataset

LiDAR  SRTM  ASTER

1 arc-second

1/3 arc-second

Maps courtesy of Dean Gesch
NHDPlus Version 2.1

Foundation for a Geospatial Hydrologic Framework for the United States

NHDPlus

2.7 million reach catchments in US
average area 3 km²
reach length 2 km
Uniquely labelled

National Elevation Dataset

Watershed Boundary Dataset

National Hydrography Dataset

National Land Cover Dataset

Slide courtesy of David Maidment
WRF-Hydro Forecasting Model

Weather model and forecasts (HRRR)

Catchment-level forecasts

Probabilistic flood forecasts

Weather → Precipitation → Runoff → Streamflow

Land-Atmosphere Model (NOAH-MP)

RAPID flow routing (for continental US)

Slide courtesy of David Maidment
National Water Data Infrastructure

Slide courtesy of David Maidment
People | Residences

LA County Building Outlines

Utah GIS Framework Data
People | Transportation
People | Employment | Commerce

Sample Bank Drive Analysis for Two Branches

Food Deserts – Atlanta, GA

LandScan USA – Houston, TX
Nightlight | Noise
Public Lab is a community where you can learn how to investigate environmental concerns. Using inexpensive DIY techniques, we seek to change how people see the world in environmental, social, and political terms.
Geospatial Tools – Proprietary systems

- Clark Labs
  - TerrSet Constellation

- Esri
  - ArcGIS Platform
  - ArcGIS Online
  - Business Analyst
  - GIS Apps

- Trimble
  - e-Cognition
  - TerraSync | Pathfinder
Open source solutions

- Fulcrum
- GRASS
- QGIS
- SAGA
- GeoDa
- R
- MapServer
- Open Layers
- CartoDB
Enduring Challenges

- **Disentangling cause & effect in cancer control**
  - Defining personal environments for cancer risk
  - Physical environment & cancer risk
  - Built environment, segregation & cancer risk
  - Social environment & cancer risk

- **Maximizing healthcare access, delivery & cancer screening**
  - Accessibility to health care services
  - Geography of screening & vaccine uptake
  - Geography of health care delivery
  - Identifying priority areas for cancer control activities

- **Impact & consequences of spatial scale on data relationships**
  - Modifiable Area Unit Problem (MAUP)
  - Strominger, Anthopolos, & Miranda (2016)

- **Using geospatial tools & data wisely**
  - Escobedo – Using the ACS to support melanoma control & prevention
Disentangling cause & effect ...
## Cumulative UV Exposure

<table>
<thead>
<tr>
<th>Cumulative exposure (Wh/m²)</th>
<th>Case-control</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 150,000</td>
<td>118/143</td>
<td>1</td>
</tr>
<tr>
<td>150,000-200,000</td>
<td>160/174</td>
<td>1.62</td>
</tr>
<tr>
<td>200,000-250,000</td>
<td>168/201</td>
<td>2.64</td>
</tr>
<tr>
<td>&gt; 250,000</td>
<td>215/191</td>
<td>6.01</td>
</tr>
<tr>
<td>p-Value</td>
<td></td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

### Average Annual UV Exposure

<table>
<thead>
<tr>
<th>45+ years</th>
<th>Case-control</th>
<th>OR</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual exposure 15-24 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4,043</td>
<td>92/122</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4,043-4,840</td>
<td>107/124</td>
<td>1.23</td>
<td></td>
</tr>
<tr>
<td>&gt; 250,000</td>
<td>215/191</td>
<td>1.74</td>
<td>0.0209 (0.0060)</td>
</tr>
<tr>
<td>Average annual exposure 25-44 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4,736</td>
<td>67/122</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4,736-5,080</td>
<td>121/116</td>
<td>1.91</td>
<td></td>
</tr>
<tr>
<td>&gt; 5,080</td>
<td>153/131</td>
<td>2.29</td>
<td>0.0002 (0.0001)</td>
</tr>
<tr>
<td>Average annual exposure 44+ years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 5,080</td>
<td>31/43</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt; 5,080</td>
<td>310/326</td>
<td>1.20</td>
<td>0.48</td>
</tr>
</tbody>
</table>
# UV Adjusted Time Spent Outdoors

<table>
<thead>
<tr>
<th>45+ years</th>
<th>Case-control</th>
<th>OR</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV adjusted outdoor 15-24 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 558,800</td>
<td>90/121</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>558,800-1,042,671</td>
<td>123/124</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>&gt; 1,042,671</td>
<td>122/122</td>
<td>1.55</td>
<td>0.0955 (0.0333)</td>
</tr>
<tr>
<td>UV adjusted outdoors 25-44 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 294,330</td>
<td>110/120</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>294,330-645,333</td>
<td>125/125</td>
<td>1.91</td>
<td></td>
</tr>
<tr>
<td>&gt; 645,333</td>
<td>105/121</td>
<td>0.99</td>
<td>0.74 (0.61)</td>
</tr>
<tr>
<td>UV adjusted outdoor 44+ years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 299,720</td>
<td>123/121</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>299,720-609,600</td>
<td>99/120</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>&gt; 609,600</td>
<td>116/127</td>
<td>0.91</td>
<td>0.74</td>
</tr>
</tbody>
</table>
Impact & consequences of spatial scale …

Primary & secondary adjacency communities …
Working with American Community Survey (ACS)

Among hotspot CTs, CTs with poor education or poor insurance coverage

Among the CTs on the left, yellow indicates poor reliability (CV>15)

Escobedo
Targeting melanoma control & prevention

NHW
Before and After Aggregation (NHW)

Before aggregation: 98 CTs (poor education or poor insurance in hotspots)

- 79 poor reliability (yellow)
- 19 good reliability (red)

- 52 adjacent
- 27 non-adjacent

16 new "neighborhoods" (blue)

After aggregation: 62 units
Results (NHW)

Education

- Before aggregation
- After aggregation

Health insurance coverage

- Before aggregation
- After aggregation

- % of CTs with low education
- % of CTs with low education and high reliability
- % of CTs with high uninsured
- % of CTs with high uninsured and high reliability
ACS Indicators (HW)

Among hotspot CTs, CTs with poor education or poor insurance coverage

Among the CTs on the left, yellow indicates poor reliability (CV>15)
Before and After Aggregation (HW)

Before aggregation: 99 CTs (poor education or poor insurance in hotspots)

- 90 poor reliability (yellow)
- 9 good reliability (red)

- 80 adjacent
- 10 non-adjacent

17 new "neighborhoods" (blue)

After aggregation: 36 units
Results (HW)

**Education**

- Before aggregation: 90.0%
- After aggregation: 70.0%

**Health insurance coverage**

- Before aggregation: 60.0%
- After aggregation: 80.0%

Legend:
- % of CTs with low education
- % of CTs with low education and high reliability

Legend:
- % of CTs with high uninsured
- % of CTs with high uninsured and high reliability
Strengths & Weaknesses

- Geographic pattern maintained & reliability improved
- Geographic pattern not maintained but reliability improved
- Geographic pattern maintained but reliability not improved
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THE GLOBAL GOALS
For Sustainable Development

1. No Poverty
2. Zero Hunger
3. Good Health and Well-Being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation, and Infrastructure
10. Reduced Inequalities
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace and Justice: Strong Institutions
17. Partnerships for the Goals